

Q.P. Code – 56922

First Year M.Sc. Degree Examination, OCTOBER/NOVEMBER 2016

(Directorate of Distance Education)

Physics

(DPA 520) Paper II — QUANTUM AND STATISTICAL MECHANICS

Time : 3 Hours]

[Max. Marks : 75/85

Instructions to Candidates :

- 1) Answer any **FIVE** questions from Parts A, B and C without omitting any Part.
- 2) Part **D** is **compulsory** for those who appear for paper with maximum marks **85**.

PART – A

1. (a) Explain in brief linear vector space, Hilbert space, linear operator and inner product of vectors.
(b) Prove that (i) Eigen values of a Hermitian operator are real (ii) Eigen functions of a Hermitian operator corresponding to different eigen values are orthogonal. **8 + 7**
2. (a) Explain the probabilistic interpretation of wave functions.
(b) Discuss Heisenberg uncertainty principle.
(c) List out the basic postulates of quantum mechanics. **5 + 5 + 5**
3. (a) Determine the energy levels and corresponding normalized Eigen functions of a particle in one dimensional potential well of the form
$$V(x) = V_0 \text{ for } 0 < x < a$$
$$= 0, x < 0 \text{ and } x > a.$$

(b) What is tunnelling through a potential barrier? Explain. **12 + 3**

PART – B

4. (a) Starting from the time independent Schrödinger equation for a one dimensional harmonic oscillator, obtain the energy eigenvalues and eigenfunctions.
(b) What are creation and annihilation operators? Explain. **8 + 7**
5. (a) Describe Stern-Gerlach experiment and explain its role in the development of quantum mechanics.
(b) Evaluate (i) $[L_x, L_y]$ and (ii) $[L^2, L_z]$. **7 + 8**

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6. (a) What are singlet and triplet states? Explain in detail.
(b) Apply the variation method for the helium atom and outline how its ground state energy is estimated. **5 + 10**

PART – C

7. (a) Write a note on phase space.
(b) Define statistical distribution function $\rho(q_k, p_k, t)$. Prove Liouville's theorem that $\rho(q_k, p_k, t)$ is a constant along every phase trajectory of the system in the phase space. **5 + 10**
8. (a) Derive Maxwell velocity distribution formula.
(b) Discuss the significance of Maxwell-Boltzmann tail of the quantum distribution formulae. **9 + 6**
9. (a) Explain Bose-Einstein condensation and discuss its significance.
(b) Explain, why liquid helium cannot be solidified by mere cooling. **9 + 6**

PART – D

10. Answer any **TWO** of the following : **2 × 5 = 10**
(a) What are the properties of Dirac delta function? Explain.
(b) Discuss Fermi Golden rule.
(c) What is Gibbs Paradox? Explain.
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